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A comparative study of fuel use and income analysis of potato production with bacteria-antagonists in Leningrad region of Russia

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Abstract

The study provides information on modern microbial preparations effect on losses reduction from potato pathogens, yield and fuel consumption per unit of production. Five potato varieties and seven microbial preparations were studied. The negative control samples received no biological treatment, and the positive control samples were processed with chemical fungicide thiabendazole. The research data include diseases prevalence, biological efficiency, healthy potato yield, notional net income, relative consumption of diesel fuel and theoretical fuel economy for studied potato varieties in case of Leningrad region. The positive control batches with thiabendazole treatment had relatively low yields of all types of processing for all potato varieties. The best yield results of all treatment variants were noticed for complex microbial fertilizer (CMF) and for *B. subtilis Ch13*. The potato yields of any microbial preparations processing variant were higher than the yields of the negative control batches. Lowest relative diesel fuel consumption was noted for batches with processing based on *B. subtilis Ch13* and CMF for Nevskiy variety – 7.7 and 7.8 l/t and Sante variety – 7.5 and 7.4 l/t, respectively. Maximum theoretical annual fuel economy in the region can be achieved with usage of *B. subtilis Ch13* treatment for all five studied varieties – 272.5 thousand l/year.

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Keywords: biological control; microbial preparations; diseases prevalence; notional net income; diesel fuel relative consumption

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1. Introduction

The idea of potato protection using natural bacteria-antagonists is based on the research results of different scientific groups, practical application of biological protection from plant pathogens and biotechnology products market trends [1–5].

Potato is one of the most important food products in Russian Federation. It is listed with other products defining the food security of the country. Microbiological spoilage of food raw materials and products of plant origin is recognized as one of the main factors reducing food supplies, providing food deficit, as well as being a source of various kinds of diseases of the population. Most damaging potato diseases are transmitted through seed tubers, which are the primary source of infection for subsequent landings contamination. Low yields and tuber spoilage during storage reduce economic indicators and spent resources efficiency of the potato production. Diesel fuel consumption for potato cultivation depends on the technology parameters, such as the number of inter-row, pesticide, fungicide and other types of treatments. The amount of used fuel for the same cultivation technology is only proportional to the land area, and so the specific fuel consumption per unit of the resulting healthy potato depends on the yield.

Modern microbial preparations provide economically significant losses reduction from potato pathogens, increase the productivity and reduce the specific fuel consumption per unit of production. There is a task of obtaining high-quality eco-friendly crop production with minimal impact on the environment. Microbiological preparations (MP) contribute to the restoration of the normal structure of the soil microbial cenosis by reducing the chemical load on agriculture land agrocenosis, partial substitution of agrochemicals and the possibility of reducing the doses of mineral fertilizers. The MP effectiveness is high, which allows their use in many countries of EU, Russia, China, US etc. [6].

2. Materials and methods

MP tests were carried out during the growing season at the experimental field, spatially isolated from industrial plantations. Experimental plot area was of 1 ha in three replications with randomized placement. Industrial field tests were twice repeated. Potatoes were grown using conventional technology under natural infectious background. The study was obtained with five potato varieties of Leningrad region selection: Nevskiy, Lugovskoy, Sante, Pushkinets, Elizabeth. The effectiveness of the potatoes biological processing was evaluated with the background of soil mineral nutrition at the rate of active substance N30 P30 K30 (in the form of starter fertilizer). The control potato batches were cultivated without biological processing with MP at the plots on the same field.

The study was obtained using 6 MP on the basis of different strains culture liquids: *B. subtilis Ch13, Ps. sp. 73, Ps. sp. 115, B. species 083, Ps. aureofaciens 35, Ps. fluorescens 15*. Culture liquids, and so the MP, contain microbial spores, vegetative cells and biologically active substances produced by the microbial cultures during their industrial cultivation.

Experimental potato batches were treated with MP by next scheme: planting material on the planting day (dose 1 l/t, $1 \cdot 10^9$ cells/ml), vegetating plants in the phase of appearance of the first leaves and in the phase of appearance of buds before flowering (dose 2 l/ha, $1 \cdot 10^9$ cells/ml). Potatoes processing with MP was performed using hand ultra-low-volume sprayer with average speed of 1 ha/h.

Plants observation was conducted throughout the growing season. Phytoregulatory activity and protective properties of bacteria-antagonists, potato yield, commercial quality of potatoes were studied. The effectiveness of microbial strains was evaluated using following parameters: the number of shoots on the 21th day after planting, plants mortality, biometric indicators of growth and development of plants.

A standard chemical contact protective fungicide thiabendazole was used for the positive control batch processing. The processing was performed by dusting on the whole tuber surface before planting with a dose of 0.5 kg/t. Thiabendazole is registered in the State catalog of pesticides and agrochemicals permitted for use in the Russian Federation.

Arbuscular-mycorrhizal fungi MP registered as CMF (complex microbial fertilizer) was also used for a batch processing (Russian Federation Patent 2318784). CMF is produced on the substrate carrier with rich agrochemical composition. The carrier is made of filtration and washing residue, which is a waste product of sugar production from sugar beet (*Beta vulgaris* L.). Freshly prepared CMF was applied by dusting on the whole tuber surface before planting with a dose of 12 kg/t.

All MP were purchased from the All-Russian Institute of Agricultural Microbiology.